Does Green Supply Chain Management enhance environmental management capacity?
A case of the machinery industry in Japan and China

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1. Introduction

Green Supply Chain Management (GSCM) is an important corporate strategy to achieve profit and market share objectives[1] (Zhu and Sarkis, 2006). At the same time, it is expected to lower environmental impacts and to raise resource efficiency at all stages of a product's lifecycle (Horiuchi and Mukai, 2006). Recently, an increasing number of companies have adopt GSCM as a new way for more efficient allocation of business resources, risk management, increase in competitiveness, and compliance with environment-related regulatory requirements. Policymakers regard GSCM as a critical measure for achieving sustainable development.

In Japan, many companies have implemented GSCM based on their advanced environmental technologies particularly in large corporations which have taken a leadership in advancing GSCM even at the global level, such as reducing environmental burden through the product life cycle, developing environmental friendly products, recycling waste, and adopting environmental management systems (Nanba, 2005). For example, the Japanese hybrid automobile and flat-panel television have gained wide popularity around the world. Energy saving, reducing environmental burden and zero-emission strategies have been applied through the process of product manufacture. Furthermore, the number of Japanese companies with ISO 14001 certification has reached 35,573 by the end of 2008. For a decade, Japan was the world's top-ranked country in this respect. Those practices are enhanced under the Basic Law for Establishing a Recycling Society, the introduction of environmental management system by companies and a greater interest for corporate social responsibility from companies (Sun et al., 2011a).

In China, companies also have adopted GSCM, particularly since China accessed the World Trade Organization (WTO). Chinese companies came to face multiple pressures from domestic and foreign environmental regulations and related stakeholders for GSCM adoption. Specifically, the Chinese government enacted the Cleaner Production Promotion Law in 2003, the Circular Economy Promotion Law in 2009, and similar environmental rules with foreign countries such as the Chinese Restriction of Hazardous Substances (RoHS) directive to solve environmental and resource problem, in order to attract foreign direct investment and increase exports. At the same time, many foreign customers that buy products or cooperate with Chinese companies require Chinese companies to comply with foreign environmental regulations such as WEEE Directive and adopt international environmental management system of ISO 14001 and other environmental management measures. By the end of 2008, the number of Chinese firms with ISO 14001 certification has reached 39,195, with China overtaking Japan as the world's top-ranked country. Moreover, with the rise of environmental understanding and intense international competition in the Chinese market, many stakeholders such as domestic customers, suppliers put pressure on companies to implement environmental measures. The environmental strategy of competitors made companies also realize that GSCM is a way to compete in global markets. These factors combined oblige Chinese companies to increase organizational efforts to promote GSCM.

The purpose of this chapter is to examine the factors that are behind the important GSCM drivers and practices in Japanese and Chinese companies by focusing on machinery industry, and clarify differences existing in the GSCM drivers and practices between the two countries. We also determine the impact factors in China and Japan. To this end, we conducted a questionnaire-based survey among Japanese and Chinese companies.

The comparative analysis between China and Japan provides implications for the effectiveness of voluntary approaches in environmental policy in countries with different stages of economic development and economic institutions. It can also provide insights into cross-border impacts of environmental policy in the era of globalization, especially when many Japanese companies relocate their plants to China. Furthermore, it may provide implications for the promotion of environmental practices in other East Asian countries and the sustainable development in whole East Asia from the viewpoint of GSCM adoption.

2. Literature review

2.1 GSCM Drivers

GSCM drivers can be classified into internal organization-related drivers and external drivers. Skillful policy entrepreneurs (Drumwright, 1994), pressures for improving quality (Pil and Rothenberg, 2003), and pressures for reducing costs (Carter and Dresner, 2001) are referred to as influential organization-related drivers, while domestic and foreign environmental regulatory compliance (Hall, 2001; Zhu and Sarkis, 2006; Sun et al, 2010a), the pressure from customers (Walton et al. 1998; Carter and Dresner, 2001; Klassen and Vacon, 2003), market competition pressure (Lamming and Hampson,1996; New et al. 2000; Zhu and Sarkis, 2006), social pressure from the public (Beamon, 1999), non-economic stakeholders (Delmas, 2001), environmental advocacy groups (Hall, 2001), and the pressure from suppliers (Klassen and Vachon, 2003; Vachon and Klassen, 2006) are considered as external GSCM drivers. Walker et al, (2008) indicate that external drivers exert more influence on companies than internal ones.

Previous studies analyzed the difference of drivers and practices by comparing different industries. Zhu et al. (2006) compare the degree of GSCM driver impacts and GSCM practices within the automobile industry, the thermal power plants and the electronic industry in China and find that drivers and practices are different among these industries, and the globalization and China's entry into the WTO have helped to promote GSCM practices in manufacturing sectors. Other studies go further to analyze the difference of GSCM drivers and practices by focusing on one industrial sector and compare it between different countries. Zhu et al. (2008a) compare the adoption and influence of GSCM practices within the automotive sectors in the UK and China, showing more similarities than differences among GSCM drivers and practices in two countries.

Overall, previous studies clarified that external drivers are more important for GSCM adoption than internal drivers. Those external drivers can be classified into three categories: domestic regulations, foreign regulations and stakeholders. Following this categorization, we focus on analyzing the difference of the external GSCM drivers in the machinery industry between Japan and China.

2.2 GSCM Practices

Previous studies explored GSCM practices by classifying them into internal and external ones. Internal practices include internal environmental management (Johnstone et al., 2007; Zhu et al, 2008b; Sun and Gao, 2007; Arimura, 2011), eco-design (Zsidisin and Hendrick, 1998; Mcauley, 2003; Zhu et al, 2008b), investment recovery (Kainuma and Tawara, 2003; Zhu et al, 2008b), and environmental accounting (Sun et al, 2010a, Sun et al, 2011a). Johnstome et al. (2007) clarify the relationships between impact factors and internal environmental management within OECD countries.

On the other hand, external GSCM practices include collaboration with customers (Vachon and Klassen, 2006; Zhu et al., 2008a) and collaboration with suppliers or green purchasing (Zsidisin and Hendrick, 1998; Geffen and Rothenberg, 2000; Carter and Sarkis, 1998; Chan and Lau, 2001; Vachon and Klassen, 2006; Sun et al., 2010a). Sun et al. (2011b) analyze the difference of GSCM practices among three industrial sectors, indicating that the GSCM practices (such as collaboration with customers and suppliers) of automobile industry show higher level than chemical and machinery industries in China. Geffen and Rothenberg (2000) explore the impact of collaboration with suppliers to environmental innovation by focusing on the automobile industry in the United States. Vachon and Klassen (2006) examine the impact of collaboration with customers and suppliers in supply chain on operational performance by focusing on the package printing industry, indicating that green project partnership with customers is positively linked to environmental performance while partnership with suppliers is associated with better delivery performance.

In this study we focus on both internal (internal environmental management; eco-design; investment recovery; environmental accounting) and external GSCM practices (collaboration with customers, collaboration with suppliers or green purchasing) to determine the differences in machinery industry between Japan and China.

3. Research methodology

3.1 Rationale of the study design

Previous studies have identified varying levels of implementation in GSCM by industrial sectors or countries (Zhu et al., 2007; Zhu et al., 2008a). Here we focus on the machinery manufacturing sector for two reasons. First, the machinery industry has to cooperate for environmental measures not only with suppliers but also with industrial customers. Most of their products are semi-manufactured products such as parts and modules but not final products for general consumer. Second, the machinery industry both in China or Japan is experiencing high environmental regulatory pressure from home and abroad. In Japan, domestic demands of machinery products have been flat since 1990 while foreign demands show a continued increase. In 2010 the exports and domestic demands of machinery industry was 671,095 and 307,527 million JPY respectively, compared with 292,990 and 848,219 million JPY respectively in 1990 (Japan Machine Tool Builders' Association, 2011). Japanese machinery firms have to compete with foreign firms in order to expand the market share and lead the global market. It obliges Japanese firms to advance high resource efficiency and low pollution products to increase their competitiveness by strict compliance with domestic environmental regulations and foreign environmental rules or beyond the original scope of regulations and rules. Therefore, Japanese companies face great pressures for advancing GSCM.

In China, machinery enterprises also face increasing domestic and foreign environmental regulatory pressure due to an increasing global competition since the WTO accession. For example, many foreign leading machinery companies with high technology expanded their business to the Chinese market. The Chinese machinery companies, which want to supply parts to foreign firms while keeping their domestic market share, have to comply with environmental practices of foreign (multilateral) companies. Furthermore, because most machinery companies are traditional state enterprises in China with high volume of pollution discharge and a lack of financial resources, Chinese central and local governments have implemented policies such as Polices for Equipment Industry Development by State Council in 2006, Enforcement Plan of Promotion of Machine Base Parts Industry in 2011 to encourage those state enterprises to promote technological innovation and environmental measures to reduce environmental burden throughout the production process for improving the competitiveness of those enterprises, and shut down high pollution emission machinery companies. All of these measure put tremendous pressure on the Chinese machinery industry to adopt green supply chain management.

3.2 Questionnaire design

The empirical data used in this study consists of questionnaire responses from Chinese and Japanese machinery companies. The questionnaire contained two sections: GSCM drivers and GSCM practices. Nine questions regarding GSCM drivers were developed by the authors and focused on domestic regulations, foreign environmental rules, and stakeholder demands which mainly related to energy saving, resource recycling and waste disposal. Questions were answered using a five-point scale (1=have never heard of it, 2= have heard of it, but don’t know any details, 3= know about it, but don’t know how it relates to our company, 4=we’re thinking about how to respond, 5= we’re already responding).

Thirty-one questions regarding GSCM practices were developed on the basis of the situation in the two countries and from examples in the literature (e.g., Zsidisin and Hendrick, 1998; Walton et al., 1998; Zhu et al. 2007; Walker et al., 2008), which focused on the following six practices; organizational efforts, eco-design, collaboration with suppliers, collaboration with customers, resource recovery, and environmental accounting. Questions were answered using another five-point scale (1=not considering it, 2= planning to consider it, 3=considering it currently, 4=initiate implementation and 5= implemented successfully).

3.3 Data collection and sampling characteristics

To avoid bias existing in different languages between Japan and China, we conducted a pre-survey to confirm the understanding of questions included in the structured questionnaire in several companies in both Japan and China before the main survey. We then improved the Japanese and Chinese questionnaire based on the results. Furthermore, we required the manager of companies’ environmental section to answer the questionnaire.

The survey of Japanese companies was conducted by choosing 200 out of about 60 thousand machinery enterprises at random by company size from manufacturing companies in Japan, and using the mail survey method in January 2010. We received 21 valid responses in total, but owing to missing data, the valid number of questionnaires used for the analysis was 20. Hence, the response rate is only 10%. In sum, 40 per cent of the respondent companies had less than 300 employees, 10 per cent had 300 to 500 employees and 50 per cent had over 500 employees (Table 1).

The survey of Chinese enterprises was carried out by choosing 400 manufacturing companies at random from the Shenyang City Economic and Technological Development Zone and the High Tech Industrial Zone, and using the self-administered questionnaire method in September 2009. There were 115 valid responses, but owing to missing data, the valid number of samples used for analysis was 113. Among them, we can find their sizes for only 64 companies from publicly released documents. In sum, 20 per cent respondent companies had less than 300 employees, 14 per cent had 300 to 500 employees and 66 per cent had over 500 employees (Table 1).

Table 1 Profile of responding machinery companies

	Japan		China	
	Total	Percentage	Total	Percentage
Size(employees)				
>500	10	50%	42	66%
300~500	2	10%	9	14%
<300	8	40%	13	20%
unknown			49	
Total	20	100%	113	100%

4. Results

4.1 Exploratory Factor Analysis for Drivers and Practices

Principal Component Analysis with VARIMAX rotation was employed to identify groups of GSCM drivers and practice from the survey data. The data were deemed appropriate for the analysis, according to the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy value of 0.86 for GSCM drivers and 0.92 for GSCM practices. The factor analysis empirically grouped the scale items of GSCM drivers and practices as assumed (Table 2 and 3), confirming our original groupings. The three GSCM driver factors identified accounted for 83.4% of the total variance. The six GSCM practice factors identified explain 80.2% of the total variance. To facilitate interpretation, only variables with a factor loading greater than 0.50 were extracted. This criterion is based on Hair et al. (1998).

Table 2 Factor analysis for GSCM drivers

	Factors		
	1	2	3
F1 Stakeholder demands			

Energy and resource conservation and pollution abatement in product development by manufacturers of similar and substitute products (competitors)	.847	.185	.160
Awareness-raising among citizens on energy and resource conservation and pollution abatement	.806	.335	.179
Supplier efforts for energy and resource conservation and pollution abatement in product development	.801	.282	.285
Customer demands on energy and resource conservation and pollution abatement	.636	.605	.185
F2 Domestic regulations and local policies			
Energy Conservation Law (Law Concerning the Rational Use of Energy)	.266	.809	.381
Basic Law for Establishing a Recycling-based Society	.249	.708	.512
Local regulations on energy and resource conservation and natural resource conservation	.488	.701	.108
F3 Foreign environmental rules			
EU regulations on expanded producer responsibility (such as WEEE)	.231	.205	.927
EU regulations on the use of specified hazardous substances (such as RoHS)	.193	.287	.902
Factor contribution	31.945	26.265	25.170

Table 3 Factor analysis for GSCM practices

	Factors					
	1	2	3	4	5	6
F1 Organizational efforts						
Commitment to energy and resource conservation and pollution abatement by company executives	.872	.223	.113	.115	.210	.026
Efforts for energy and resource conservation and pollution abatement by means of inter-division collaboration	.849	.248	.115	.099	.246	.064
Training for employees on energy and resource conservation and pollution abatement	.843	.260	.182	.162	.268	.075
ISO 14001 certification	.775	.278	.207	.185	.147	.018
Creating an in-house environmental auditing program	.633	.190	.206	.092	.242	.492
Environmental auditing of company by outside agency	.626	.168	.323	.049	.377	.229
Public release of environmental reports	.529	.309	.297	.063	.293	.439
F2 Collaboration with customers						
Partnerships with customers on reducing energy consumption in the product transport process	.238	.778	.184	.154	.245	.265
Collaboration with customers for cleaner production	.188	.778	.318	.159	.206	.228
Collaboration with customers for eco-friendly packaging	.333	.770	.250	.173	.191	.054
Collaboration with customers for recovery of defective and used goods	.276	.769	.164	.191	.165	.141
Adoption of third-party logistics	.342	.722	.181	.153	.316	.141
Collaboration with customers for eco-design	.329	.692	.363	.167	.163	.201
Working with customers on waste transport and other reverse logistics	.102	.648	.375	.235	.128	.231
F3 Collaboration with suppliers						
Assessing initiatives by secondary supplier for energy and resource conservation and pollution abatement	.030	.289	.736	.251	.044	.289
Environmental and energy audits to suppliers	.236	.403	.705	.142	.227	.150
Collaboration with suppliers for energy and resource saving and pollution conservation	.404	.373	.662	.091	.345	-.025
Certification for ISO 14001 or other environmental management system by supplier	.384	.312	.632	.192	.295	.061
Giving design specifications to suppliers (including requirements for the energy conservation, resource conservation, and pollution abatement of items to be purchased)	.406	.397	.613	.136	.319	.133
Adoption of just-in-time distribution system	.448	.221	.523	.240	.046	.165
F4 Resource recovery						
Selling surplus capital equipment	.040	.239	.056	.801	.270	.127

Selling used and scrap materials	.282	.179	-.017	.779	.096	.007
Recovery of sold products and materials that have exceeded their durable years	-.045	.066	.353	.763	-.073	.137
Building recycling systems for used and defective goods	.093	.016	.334	.753	.046	-.010
Selling surplus inventories of raw materials and products	.265	.378	-.038	.751	.221	-.005
F5 Eco-design						
Product design which considers recovery, reuse, and recycling of products and parts	.280	.244	.223	.162	.800	.203
Design of production processes that consider reducing and avoiding use of hazardous substances	.473	.286	.162	.163	.707	.169
Production process design for waste minimization	.405	.370	.170	.207	.705	.133
Product design that considers reduced consumption of raw materials and energy	.444	.320	.208	.131	.694	.089
F6 Environmental accounting						
Employee compensation linked with achievements in energy and resource conservation and pollution abatement	-.023	.273	.098	.049	.076	.800
Instituting environmental accounting	.358	.231	.232	.106	.237	.720
Factor contribution	19.574	18.281	12.406	11.654	11.219	7.101

We kept the labels of the three factors on GSCM drivers that included domestic regulations and local policies, foreign environmental rules, and stakeholder demands (Table 4). Further analysis confirms the reliability of these three factors with Cronbach's alpha, of 0.86, 0.91, and 0.90, respectively for each group. The six factors on practices can be labeled as organizational efforts, eco-design, collaboration with suppliers, collaboration with customers, resource recovery, and environmental accounting. Further analysis confirms the reliability of these six factors with Cronbach's alpha of 0.95, 0.96, 0.93, 0.96, 0.88, and 0.74, respectively. All Cronbach alpha values are well above the limit of 0.70 established by Nunnally (1978) and Sekaran (1992) to ensure the construct's internal consistency and validity. In addition, the item-total correlation of all items ranged from 0.44 to 0.92.

Table 4 Alpha values for each GSCM factor

Factors			No. of items	Cronbach's alpha	Range of item-total correlations
Drivers	F1	Stakeholder demands	4	0.90	0.66-0.76
	F2	Domestic regulations and local policies	3	0.86	0.55-0.80
	F3	Foreign environmental rules	2	0.91	0.91-0.91
Practices	F1	Organizational efforts	7	0.95	0.61-0.92
	F2	Collaboration with customers	7	0.96	0.65-0.89
	F3	Collaboration with suppliers	6	0.93	0.56-0.89
	F4	Resource recovery	5	0.88	0.44-0.77
	F5	Eco-design	4	0.96	0.83-0.92
	F6	Environmental accounting	2	0.74	0.59-0.59

4.2 Differences between Japanese and Chinese companies

Two-tailed independent samples *t*-tests were employed to examine differences in the mean values of GSCM drivers and practices between Japan and China's machinery companies. Through normality test we confirmed that the samples in China and Japan are normally distributed.

Table 5 Comparison regarding GSCM drivers

	China (n=113)		Japan (n=20)			
	Mean	SD	Mean	SD	*T*	Sig.
Overall GSCM Drivers	2.46	0.80	4.06	1.04	-7.91	***
F2 Domestic regulations and local policies	2.65	0.95	4.31	0.99	-7.18	***
Energy Conservation Law (Law Concerning the Rational Use of Energy)	2.58	1.09	4.55	0.83	-9.18	***
Basic Law for Establishing a Recycling-based Society	2.51	1.07	3.95	1.54	-4.01	***
Local regulations on energy and resource conservation and natural resource conservation	2.80	1.09	4.58	0.90	-6.72	***
F3 Foreign environmental rules	1.97	1.05	3.74	1.50	-4.93	***
EU regulations on expanded producer responsibility (such as WEEE)	1.95	1.09	3.53	1.58	-4.20	***
EU regulations on the use of specified hazardous substances (such as RoHS)	1.99	1.05	3.95	1.58	-5.20	***
F1 Stakeholder demands	2.73	0.94	4.07	1.07	-5.72	***
Customer demands on energy and resource conservation and pollution abatement	2.74	1.10	4.40	1.10	-6.21	***
Awareness-raising among citizens on energy and resource conservation and pollution abatement	2.61	1.11	3.89	1.13	-4.53	***
Supplier efforts for energy and resource conservation and pollution abatement in product development	2.71	1.13	4.15	1.18	-5.18	***
Energy and resource conservation and pollution abatement in product development by manufacturers of similar and substitute products (competitors)	2.73	1.10	3.68	1.49	-2.66	**

*p<0.05; **p<0.01; ***p<0.001

Table 6 Comparison regarding GSCM practices

	China(n=113)		Japan(n=20)			
	Mean	SD	Mean	SD	*T*	Sig.
Overall GSCM Practices	2.55	0.81	3.47	1.05	-4.46	***
F1 Organizational efforts	2.40	0.96	4.28	1.14	-7.85	***
Commitment to energy and resource conservation and pollution abatement by company executives	2.53	1.12	4.60	0.94	-7.79	***
Efforts for energy and resource conservation and pollution abatement by means of inter-division collaboration	2.50	1.14	4.45	1.15	-7.05	***
Training for employees on energy and resource conservation and pollution abatement	2.47	1.13	4.50	1.10	-7.41	***
ISO 14001 certification	2.29	1.17	4.56	1.15	-7.64	***
Creating an in-house environmental auditing program	2.41	1.03	4.11	1.66	-4.30	***
Environmental auditing of company by outside agency	2.30	1.21	4.11	1.66	-5.67	***
Public release of environmental reports	2.24	1.18	3.55	1.85	-3.05	*
F5 Eco-design	2.76	1.12	4.07	1.28	-4.71	***
Product design that considers reduced consumption of raw materials and energy	2.71	1.21	3.95	1.57	-4.05	**
Product design which considers recovery, reuse, and recycling of products and parts	2.77	1.11	3.68	1.49	-2.56	**

Design of production processes that consider reducing and avoiding use of hazardous substances	2.73	1.25	4.28	1.32	-4.83	***
Production process design for waste minimization	2.79	1.19	4.06	1.39	-4.07	***
F3 Collaboration with suppliers	2.51	0.98	3.31	1.21	-3.24	**
Giving design specifications to suppliers (including requirements for the energy conservation, resource conservation, and pollution abatement of items to be purchased)	2.72	1.09	3.95	1.47	-4.37	***
Collaboration with suppliers for energy and resource saving and pollution conservation	2.54	1.20	3.55	1.61	-3.27	*
Environmental and energy audits to suppliers	2.49	1.17	2.84	1.46	-1.17	
Certification for ISO 14001 or other environmental management system by supplier	2.42	1.14	3.11	1.45	-1.96	*
Assessing initiatives by secondary supplier for energy and resource conservation and pollution abatement	2.45	1.04	2.32	1.42	0.48	
Adoption of just-in-time distribution system	2.41	1.10	3.72	1.49	-3.59	***
F2 Collaboration with customers	2.40	1.06	3.25	1.43	-2.53	*
Collaboration with customers for eco-design	2.30	1.14	3.33	1.68	-2.52	*
Collaboration with customers for cleaner production	2.37	1.12	2.88	1.69	-1.20	
Collaboration with customers for eco-friendly packing	2.35	1.17	3.11	1.57	-1.98	*
Partnerships with customers on reducing energy consumption in the product transport process	2.45	1.20	2.83	1.47	-1.20	
Adoption of third-party logistics	2.56	1.27	3.35	1.62	-1.93	**
Collaboration with customers for recovery of defective and used goods	2.47	1.16	3.41	1.77	-2.13	*
Working with customers on waste transport and other reverse logistics	2.39	1.19	2.67	1.68	-0.66	
F4 Resource recovery	2.72	0.97	3.42	1.25	-2.31	*
Selling surplus inventories of raw materials and products	2.76	1.14	3.61	1.38	-2.86	*
Selling used and scrap materials	2.73	1.18	3.89	1.53	-3.07	
Selling surplus capital equipment	2.83	1.20	2.94	1.52	-0.28	
Recovery of sold products and materials that have exceeded their durable years	2.64	1.16	2.76	1.71	-0.29	
Building recycling systems for used and defective goods	2.69	1.14	3.12	1.58	-1.07	
F6 Environmental accounting	2.48	0.97	2.43	1.33	0.17	
Employee compensation linked with achievements in energy and resource conservation and pollution abatement	2.50	1.05	1.75	1.07	2.94	
Instituting environmental accounting	2.45	1.02	3.10	1.83	-1.54	

*p<0.05; **p<0.01; ***p<0.001

4.3 Drivers of GSCM

Table 5 shows that statistically significant differences, i.e., p<0.001, exist between Japan and China in the overall GSCM drivers, as well as all three underlying factors. Domestic regulations and local policies show the largest difference between these two countries, followed by stakeholder demands and foreign environmental rules.

All factors and their underlying items have attained mean values over or close to 4.00 in Japanese companies, while less than 3.00 in China. This suggests that Japanese companies have experienced higher pressures from these GSCM drivers than Chinese companies. Based on the results shown in Table 5, we will elaborate each factor of GSCM drivers.

4.3.1 Domestic regulations and local policies

Domestic regulations and local policies (mean=4.31) is the largest driver in Japan, while in China it is a relatively higher driver, but not the largest one (mean=2.65). One reason for this difference is that the Japanese government has introduced strict laws such as an energy saving law and the Basic Law for Establishing a Recycling-based Society due to Japan's past serious environmental pollution, waste disposal problems and dealing with global environmental issues. Some local governments also implemented environmental and economic policies to push enterprises to save energy and protect environment. Kawasaki City, for example, implements policies for building an eco-town to support setting up energy and resources saving businesses by using their high-level recycling technologies, such as using waste and by-products as raw material (Fujita et al., 2007).

The Chinese government also has enacted laws to encourage the machinery industry to adopt GSCM. The central government implemented the Cleaner Production Promotion Law in 2003, Circular Economy Promotional Law in 2009 and several subsidy policies such as Promotion Project for Revitalizing the Northeastern Traditional Industry Base. Based on the laws and policies, some local governments initiated projects to promote GSCM, including Shenyang government's building machinery industry base project (Sun et al., 2011b). These projects enhanced the motivation of companies to adopt GSCM at a certain level, but have not yet functioned adequately due to a lack of specific measures of GSCM related laws and knowledge of GSCM (Sun and Mori, 2008). Therefore, domestic regulations and local policies has not been the main driver for Chinese machinery industry to adopt GSCM.

4.3.2 Foreign environmental rules

Foreign environmental rules (environmental rules in exporting countries) prove to have the lowest mean values both in Japan (3.74) and in China (1.97). Japanese companies have already taken initiative with regard to GSCM and have implemented similar or higher level GSCM through management of toxic chemicals, recycling of used products with foreign developed countries due to Japan's past environmental pollution and waste measures, risk management and greater implementation of environmental management system and environmental technologies (Horiuti and Mukai, 2006; Sun et al., 2011a). Hence Japanese companies follow the foreign environmental rules for exporting products overseas but exporting products was not the reason to make them to start to adopt GSCM.

On the other hand, Chinese machinery companies still have a relatively low level of technology. Most of the responding companies in this survey are state-owned enterprises, which mainly provide products for the Chinese market. Some companies want to comply with foreign environmental rules such as WEEE, RoHS Directives in EU market to expand their exports, but still are in the process of considering them due to a lack of information and knowledge. Therefore China and Japan have different situations with regard to foreign environmental rules though both of them feel relatively low pressure from foreign environmental rules.

4.3.3 Stakeholder demands

The factor of stakeholder demands is the largest driver in China (mean=2.73), while it is the second for Japan (mean=4.07). The results show two main features. First, environmental demands from customers play the most important role for promoting GSCM in both countries (Japanese mean=4.40; Chinese mean=2.74). The reason is that Japanese machinery companies provide products to their customers in global markets including not only developing countries but also industrialized countries, so they face more stringent environmental requirements (Institute of Applied Energy, 2010). On the other hand, most Chinese machinery companies in this survey do business in the domestic market, where the overall level of company's GSCM adoption is still at a beginning stage due to the lower technology level and countryside location.

Second, competitors' green strategy (mean=2.73) shows higher promotional impact in China, while being smallest in Japan. Many Japanese machinery companies have already provided the world's top-level environmental friendly products, such as hybrid shovel and solar cell module, due to their high level environmental technologies and environmental management system. They remained to rank number one with regard to order volume in the world by 2007 because of their high quality (Hirano, 2010). Therefore, it seems that Japanese companies do not care much about competitors' green strategy.

On the other hand, Chinese companies have to compete in the domestic market with similar environmental technological level. To gain the economic profits they first need to pay high attention to the environmental strategy of competitors. Therefore, competitors' green strategy seems to be an important promotional item for GSCM adoption in China.

4.4 GSCM practices

Table 6 shows a significant difference in overall GSCM practice between Chinese and Japanese machinery companies. Among the six groups of underlying factors, mean values of five factors namely organizational efforts, eco-design, collaboration with suppliers, collaboration with customers and resource recovery show significant differences, while no significance is found for the differences in environmental accounting between China and Japan. All factors of GSCM practices have attained mean values over 3.00 in Japan except for environmental accounting, while being less than 3.00 in China. This difference implies that Japanese machinery companies have taken an initiative in implementation of these GSCM practices, while Chinese ones are still at the stage of taking these GSCM practices into consideration. Each factor of GSCM practices is discussed based on the result shown in Table 6 as follows.

4.4.1 Organizational efforts

The greatest difference exists between Japan and China with regard to organizational efforts. The mean value of organizational efforts (4.28) in Japanese machinery companies shows the highest implementation level, while that of Chinese companies is lowest (2.40). This implies that Japanese machinery companies attach high importance on organizational efforts, whereas Chinese enterprises have a low priority for it.

This difference can be explained by perceived profit opportunities in the long term. At present, most machinery companies in China, which formed under the centrally planned economy and are equipped with weak economic powers, have to give priority to achieve short-term profits and end-of-pipe environmental measures. The practice of organizational efforts such as obtaining ISO 14001certification requires high investment cost while it does not bring direct or short-term business and environmental profit. By contrast, Japanese machinery enterprises have strong economic power and are under strict environmental regulation, while attaching importance to organizational efforts as a competition strategy and a prevention environmental strategy like risk management (Horiuti and Mukai, 2006).

4.4.2 Eco-design

The factor of eco-design also showed significant difference between Japan and China. The mean value of Chinese machinery enterprises (2.76) shows the greatest implementation level, and that of Japanese machinery enterprises (4.07) shows greater implementation level than the average value (3.47).

Further analysis for the variables within eco-design finds that both China and Japan attach importance to eco-design but from different directions. Japanese companies put emphasis on avoiding hazardous chemicals usage with mean of 4.28, while Chinese companies pay more attention on design for reducing waste (2.79) rather than design for avoiding hazardous chemicals (2.73). It seems to be related with Pollutant Release and Transfer Register (PRTR) law as one of risk management measures in Japan, which put high pressures on Japanese companies to conduct GSCM for avoiding environmental cost (Horiuti and Mukai, 2006).

On the other hand, in China, even though the government introduced the regulations in terms of hazardous chemicals management in 2002, it still has yet to take full effect due to the lack of specific provisions. Specifically, there are no detailed rules on who should take responsibility for solving hazardous chemicals issues (State Council of China, 2002). Recently the Chinese government has made efforts to revise environmental laws. A hazardous chemicals management law will be introduced in December 2011 (State Council of China, 2011). For such kind of situation, some GSCM practices linked to decreasing production cost such as the design for reducing waste with mean of 2.79 were conducted more in China.

4.4.3 Collaboration with suppliers

The factor of collaboration with suppliers shows a marked difference between the two countries. The major variable that causes differences for collaboration with suppliers (mean=3.31) is the one giving design specification (including requirements for the energy, resource conservation, and pollution abatement of items to be purchased) and adoption of just-in-time logistic system.

The results show two main features. Firstly, both the mean with 3.95 in Japan and 2.72 in China are the highest values within the underlying items of collaboration with suppliers, which means that both countries are making efforts for showing the design specification for environmental conservation. The practice of Chinese companies may be related to domestic regulation and local policies and stakeholder demands. Specifically, the Chinese government introduced a new institution to assess local governments by rates of energy saving and environmental burden reducing, as well as several laws such as the Circular Economy Promotion Law. Under these pressures Shenyang city government introduced several environmental and economic policies especially for machinery companies, such as removing enterprises from the city center to industrial zones in the suburban area with a forced cleaner production adoption (Sun et al., 2011b). One reason is that the machinery industry is the major economy in Shenyang city, so the government wants to promote its economy by environmental measures. According to the Statistics Shenyang, the added-value of machinery factories of above a certain size (All state owned companies and non-state owned industrial companies with over CNY 5 million annual sales) accounted for 48% of that of total industry in 2009. Second, most machinery companies are traditional state-owned companies with high environmental burden. On the other hand, the domestic regulations also cause impacts to industrial customers due to the industry’s characteristic of producing intermediate goods such as parts. Hence to reduce environmental burden, machinery companies have to not only place emphasis on internal eco-design but also cooperate with suppliers by providing environment friendly specification.

Secondly, the mean of adoption of just-in-time logistic system showed higher value in Japan while having the lowest value in Chinese companies. This can be explained by the efficiency strategy of business in Japanese companies which sell products for a competitive global marketplace. According to statistical data of Japanese machinery tools, value of export from Japanese machinery industry accounted for 56% of GDP in 2008 (Hirano, 2010). Japanese machinery companies implement actively just-in-time logistic system to save inventory cost to maximize profits against international competition. On the other hand, Chinese machinery companies have not yet achieved a smooth collaboration with suppliers especially for logistic GSCM due to the lack of good management systems and knowledge.

4.4.4 Collaboration with customers

The factor of collaboration with customers shows a slight difference between the two countries. It should be noted that its mean value of 2.40 shows the lowest level within the factors of GSCM practices in China, and it (mean=3.25) also shows a lower than average value of GSCM practices in Japan. It seems that Japanese machinery companies have collaborated with customers but they do not give high priority on this, while for Chinese companies they have not attached importance to it, especially for collaborating with customers for eco-design and green packing. It seems that most Chinese machinery companies positively comply with environmental requirements from customers as mentioned in 4.3.2, but not to seek collaboration with customers on environmental practices.

On the other hand, further analysis shows that the item of third-party logistics mainly generated difference in collaboration with customers between Japanese and Chinese machinery companies. It is interesting that this item not only shows the highest value (mean=2.56) but also higher than the overall average value (mean=2.55) of GSCM practices for the case of China. Also for Japan, the item of third-party logistics shows higher value (mean=3.35) among the underlying items of collaboration with customers, even though it is lower than the overall average value (mean=3.47) of GSCM practices. It seems that Chinese companies attach importance to building an efficient logistic system with customers compared to most others GSCM practices, because it is directly related to corporate profits.

4.4.5 Resource recovery

The factor of resource recovery also shows a slight difference between Japan and China. It should be noted that resource recovery (mean=2.72) constitutes a relatively high level GSCM practice in China, while that of Japanese machinery companies (mean=3.42) is lower than the average mean value (mean=3.47). One reason for Japanese machinery companies may relate to the great efforts for eco-design such as the measures for resource reuse and recycling as mentioned in 4.4.2, and organizational efforts such as a high level environmental management system of ISO 14001 as mentioned in 4.4.1. This means that the implementation of GSCM as preventive measures has promoted the practices of resource recovery from different directions, so it is not necessary for Japanese companies to put their strongest efforts into resource recovery. Further analysis shows that only the underlying item of selling surplus inventories of raw material and products show difference between Japan (mean=3.61) and China (mean=2.76). It should be noted that the mean value of Japanese companies is higher than the overall average value of GSCM practices. This is due to the fact that most Japanese machinery companies have adopted just-in-time logistic system (mean=3.72) as mentioned at 4.4.3, so they can deliver only the necessary amount of raw material when it is necessary, and this system is also linked to reduce stock products. This system enables Japanese companies to implement this GSCM practice relatively easily.

On contrary, Chinese machinery companies show low level and high variation in implementation of organizational efforts and eco-design. This implies that most of them attach more importance to resource recovery, which is linked to the direct benefit from selling redundant materials and by-products.

4.4.6 Environmental Accounting

The factor of environmental accounting shows no significance differences between China and Japan. It should be noted that environmental accounting in both Japan (mean=2.48) and China (mean=2.43) is lower than each average value of GSCM practices. It suggests that both China and Japan need to make more efforts for environmental accounting.

5. Discussion

Overall, there are significant differences in all drivers for GSCM adoption and the implementation of GSCM practices between Japan and China except for environmental accounting.

This study finds that domestic regulation and local policy is the largest driver for GSCM adoption in Japan, followed by stakeholder demands and foreign environmental rules. This means that the government’s direct regulation mainly promoted GSCM adoption. This can be explained by Japan’s historical experience of strict environmental regulations to tackle industrial pollution, waste management and recycling, global environmental problems, and companies’ risk management as preventive environmental management under these regulations. The market also plays an important role due to Japanese machinery companies’ competition in the global market.

By contrast, the factor of stakeholder demands is the largest driver in China, meaning that the market places more pressure on GSCM adoption than the government's direct regulations. However, the pressures on Chinese machinery companies to adopt GSCM are still much lower. This can be explained by lax enforcement of environmental regulations and heavy reliance on domestic sales that leads to weak international market pressures. For GSCM to function beyond the government direct regulations, it is important to empower stakeholder demands under the market mechanism.

Furthermore, we found a big difference in GSCM practices between Japan and China. Japanese machinery companies have implemented a high level GSCM practices including both internal and external environmental measures. GSCM practices are becoming a more effective tool for increasing companies' environmental management capacity and market competition throughout the supply chain in the whole product life cycle in Japan.

Meanwhile, in China GSCM practices are still in their infancy. The reason for this gap is that Japanese machinery companies attach importance to promoting the GSCM practices for risk management as a preventive environmental measures and global competition in the long run, while Chinese companies focused more on short-term profits. This is attributed to differences in the economic development stage. The role of GSCM practices for improving companies' environmental management capacity and market competition is still limited in China. Further globalization of the Chinese domestic market may prompt Chinese companies to raise the overall level of understanding of GSCM. Future challenges reside not in government direct regulation but in market pressure in China.

6. Summary and Conclusion

This chapter presents results from a comparative analysis of GSCM drivers and practices between Japanese and Chinese machinery industry to examine whether GSCM can be an instrument to force companies to implement environmental practices to comply with and move beyond regulatory requirements. The main findings are as follows. First, Japanese companies feel much higher pressures from all three drivers of domestic regulations and local policies, stakeholder demands, and foreign environmental rules than Chinese ones. Second, domestic regulations and local policies provide the highest pressure in Japan, while stakeholder demands put the largest pressure to companies in China. Third, Japanese companies have conducted much higher level GSCM practices than Chinese companies. In Japan, GSCM is becoming an effective tool for increasing environmental management capacity and market competition, while GSCM adoption in China is still mainly pushed by government direct regulation rather than the market mechanism. In China, the future key will be to further integrate the Chinese market into the global economy to make companies implement GSCM by themselves under the market mechanism.

In a globalizing economy, the increasing number of companies has accelerated international division of labor in the East Asian region. As seen in Chapter 1 in this volume, both inflow and outflow of FDI has been expanded in East Asia in the 2000s. In this process, new supply chains have been created in different countries. Accordingly, GSCM practice may be diffused internationally. To acknowledge the impact of market-based environmental policy instruments on the development of national environmental management capacity, it is indispensable to expand the scope of this chapter to conduct an impact analysis of cross-border impacts of GSCM by focusing on the companies linked by the supply chain in different countries, and to clarify the diffusion mechanism of cross-border GSCM practice.

Notes

1. Over the years there have been many variations of definitions and practices in GSCM such as green purchasing and green logistics. This chapter adopts the definition of Sarkis et al. (2011) to define it as a measure to integrate environmental concerns into the inter-organizational practices of supply chain management.

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